Subterranean Biology 19: 23–29 (2016)
doi: 10.3897/subtbiol.19.9513
http://subtbiol.pensoft.net

RESEARCH ARTICLE

A peer-reviewed open-access journal
Subterranean Biology
Published by The International Society for Subterranean Biology

A new interstitial species of diving beetle from tropical northern Australia provides a scenario for the transition of epigean to stygobitic life (Coleoptera, Dytiscidae, Copelatinae)

Chris H.S. Watts[1], Lars Hendrich[2], Michael Balke[2,3]

1 *Department of Entomology, South Australian Museum, North Terrace, Adelaide, SA 5000, Australia* **2** *Zoologische Staatssammlung, Münchhausenstrasse 21, 81247 München, Germany* **3** *GeoBioCenter, Ludwig-Maximilians University, Munich, Germany*

Corresponding author: *Michael Balke* (kaefer@zsm.mwn.de)

Academic editor: *O. Moldovan* | Received 10 June 2016 | Accepted 19 July 2016 | Published 29 July 2016

http://zoobank.org/47000C3A-A8C4-4BC6-BB4C-063C46D20BD6

Citation: Watts CHS, Hendrich L, Balke M (2016) A new interstitial species of diving beetle from tropical northern Australia provides a scenario for the transition of epigean to stygobitic life (Coleoptera, Dytiscidae, Copelatinae). Subterranean Biology 19: 23–29. doi: 10.3897/subtbiol.19.9513

Abstract

Exocelina saltusholmesensis **sp. n.** is described from a single female collected in Holmes Jungle Reserve near Darwin in the Northern Territory, Australia. Phylogenetically, the new species is sister to a clade containing the epigean *E. ferruginea* (Sharp, 1882) and *E. punctipennis* (Lea, 1899) but well characterized by its smaller size, the much smaller eyes, vestigial wings and paler surface. *Exocelina saltusholmesensis* **sp. n.** was collected from a small pool in an intermittent and temporary small creek. The collecting circumstances suggest that this is an interstitial species, with morphological characters interpreted as adaptations to a strongly hidden if not mostly subterranean lifestyle.

Keywords

Beetles, interstitial aquatic fauna, adaptation to subterranean life

Copyright *Chris H.S. Watts et al.* This is an open access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Introduction

The diving beetle genus *Exocelina* contains more than 140 described species, most of them in New Guinea and New Caledonia (Toussaint et al. 2014, 2015; Nilsson 2015). The majority of species occur in habitats associated with streams, but there were also four transitions to stagnant water habitats (Toussaint et al. 2015). Two highly derived stygobitic Australian species have been described to date, *Exocelina abdita* Balke et al. 2004 from Newhaven Station, Camel Bore, Northern Territory and *E. rasjadi* Watts & Humphreys, 2009 from Tjukurla calcrete, Lake Hopkins palaeovalley, Western Australia. Both species are blind (Fig. 2B, 3C), have vestigial wings, are depigmented and show a more or less pronounced constriction between base of pronotum and elytra (Fig. 2B) which is linked to reduction of flight muscles (Balke et al. 2004, Watts and Humphreys 2009). Another rarely collected Australian species, *Exocelina australis* (Clark, 1863), has smaller eyes than typical epigean species and is only lightly pigmented (Fig 2A). This might indicate a hidden, interstitial lifestyle. The collection of the species from hyporheic environments of a number of localities in the Flinders Range also hints in this direction (Leys et al. 2010).

Here, we describe a new species collected from a small pool in the bed of a slowly flowing wet-season creek near Darwin. Morphological features such as reduced eyes and vestigal wings, light pigmentation and absence of the species from other nearby water bodies suggest this is an interstitial species providing a scenario for the transition from epigean to stygobitic life. This discovery highlights the hidden diversity of an underexplored habitat.

Methods

Morphological observations were made and measurements were taken with a Leica M205 C stereomicroscope. Specimens were illuminated by a diffuse 13W fluorescent double light tube.

A DNA sequence of the 3' fragment of the mitochondrial cytochrome oxidase 1 gene was generated by Remko Leys at the South Australian Museum in Adelaide, using the oligonucleotide primers Jerry and Pat (TCC AAT GCA CTA ATC TGC CAT ATT A / CAA CAT TTA TTT TGA TTT TTT GG).

Digital images were taken with a Nikon D3X equipped with a bellow or expansion rings and lenses: Mitutoyo 10x ELWD Planapo or Leitz Photar 25/2.8. Illumination came from three compact Nikon flashes, and the instrument was moved on an Isel linear drive (https://www.isel.com/at/lineareinheiten-les6.html) or Cognisys Stackshot (for very small steps 1–7 μm) (www.cognisys-inc.com). Image stacks were combined using the method A in Helicon focus software (www.heliconsoft.com).

Results

Family Dytiscidae Leach, 1815
Genus *Exocelina* Broun, 1886

***Exocelina saltusholmesensis* sp. n.**
http://zoobank.org/90C3C890-B056-4AA3-9A3D-82CB91BA2D0B
Figs 1, 3

Type locality. Small seasonal creek [-12.400714° 130.931297°], Holmes Jungle Reserve, Darwin, Northern Territory, Australia.

Type material. Holotype, female (South Australian Museum Adelaide, SAMA): "Australia, Northern Territory, Darwin, Holmes Jungle Reserve, -12.400714° 130.931297°, 25. March 2004, C.H.S. Watts (SAMA database no. 25-012926)". The beetle was originally labelled as "Copelatus sp.nov." by C.H.S. Watts and has now a red, printed holotype label attached in addition.

European nucleotide archive (genbank) accession number for the 3' end of the mitochondrial cytochrome c oxidase 1 gene: www.ebi.ac.uk/ena/data/view/LN994839

Description. *Size and shape*: Beetle small (length of beetle 3.7 mm, greatest width 1.8 mm, length of pronotum 0.6 mm, width of pronotum at base 1.7 mm), comparably parallel-sided (Fig. 1C).

Coloration. Mainly testaceous and slightly translucent with lighter band on elytral base and darker area in middle basal area of pronotum (Fig. 1C).

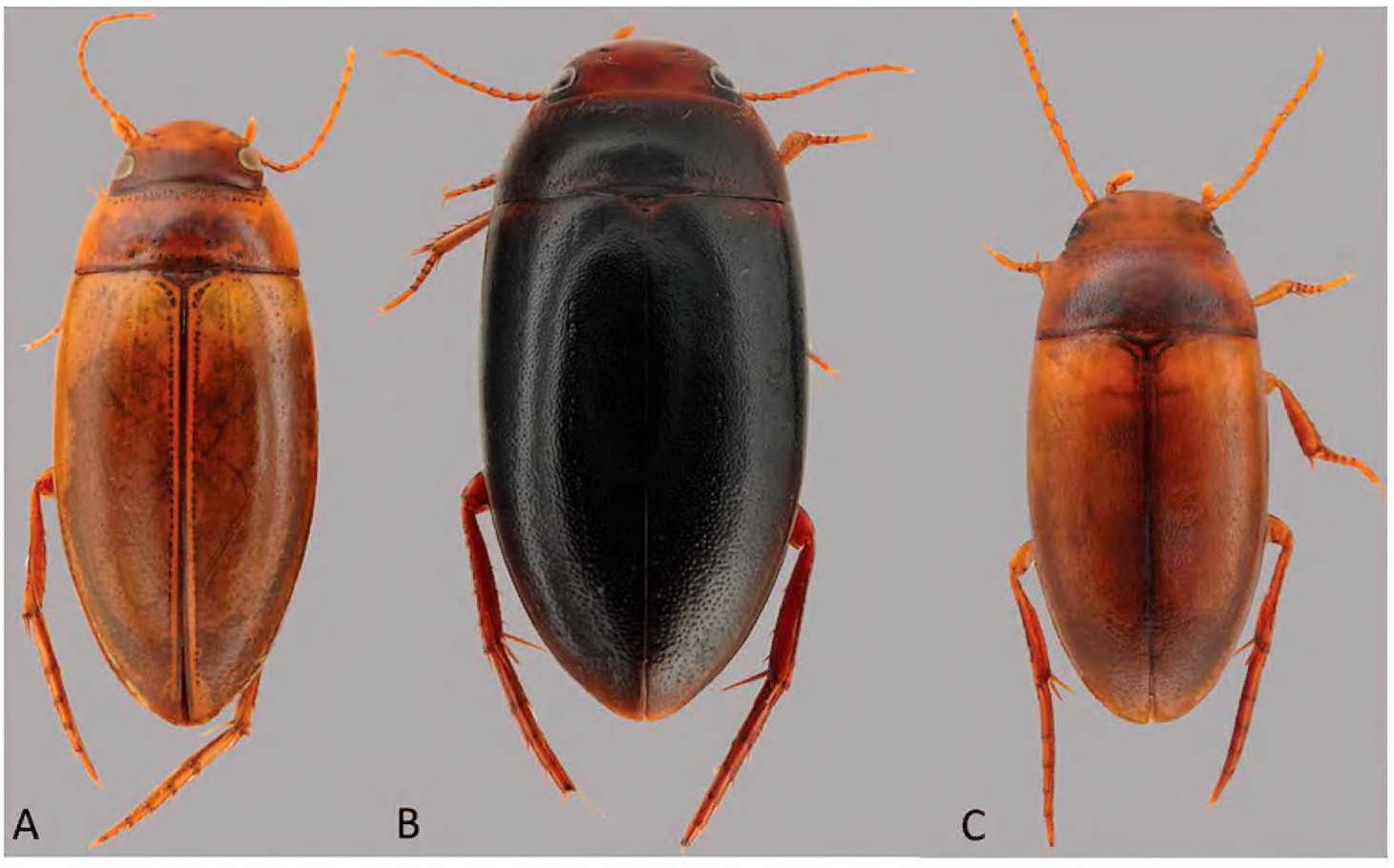

Figure 1. Habitus of *Exocelina* species: *E. ferruginea* (**A**), *E. punctipennis* (**B**), *E. saltusholmesensis* sp. n. (**C**).

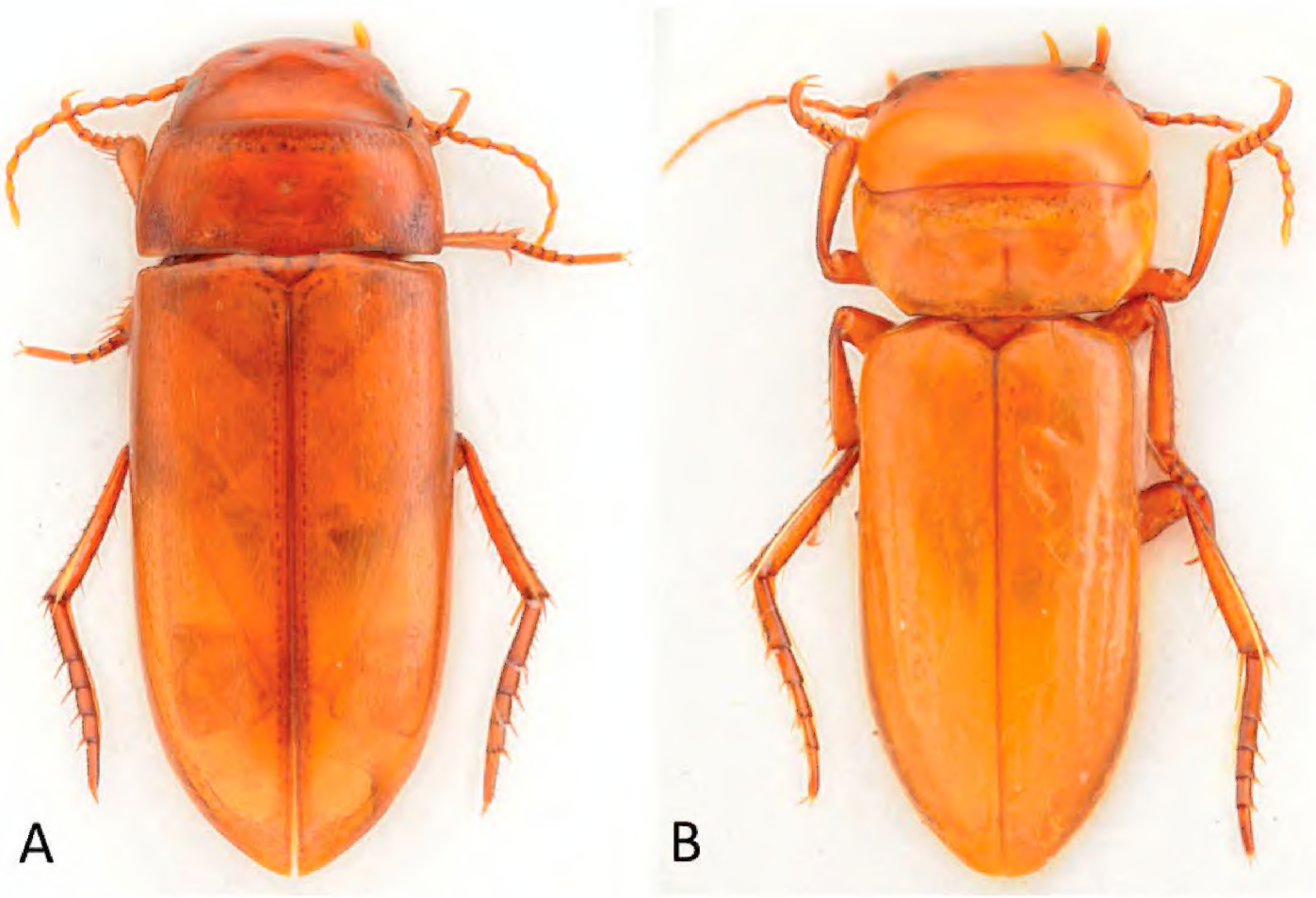

Figure 2. Habitus of *Exocelina* species: *E. australis* (**A**), *E. abdita* (**B**).

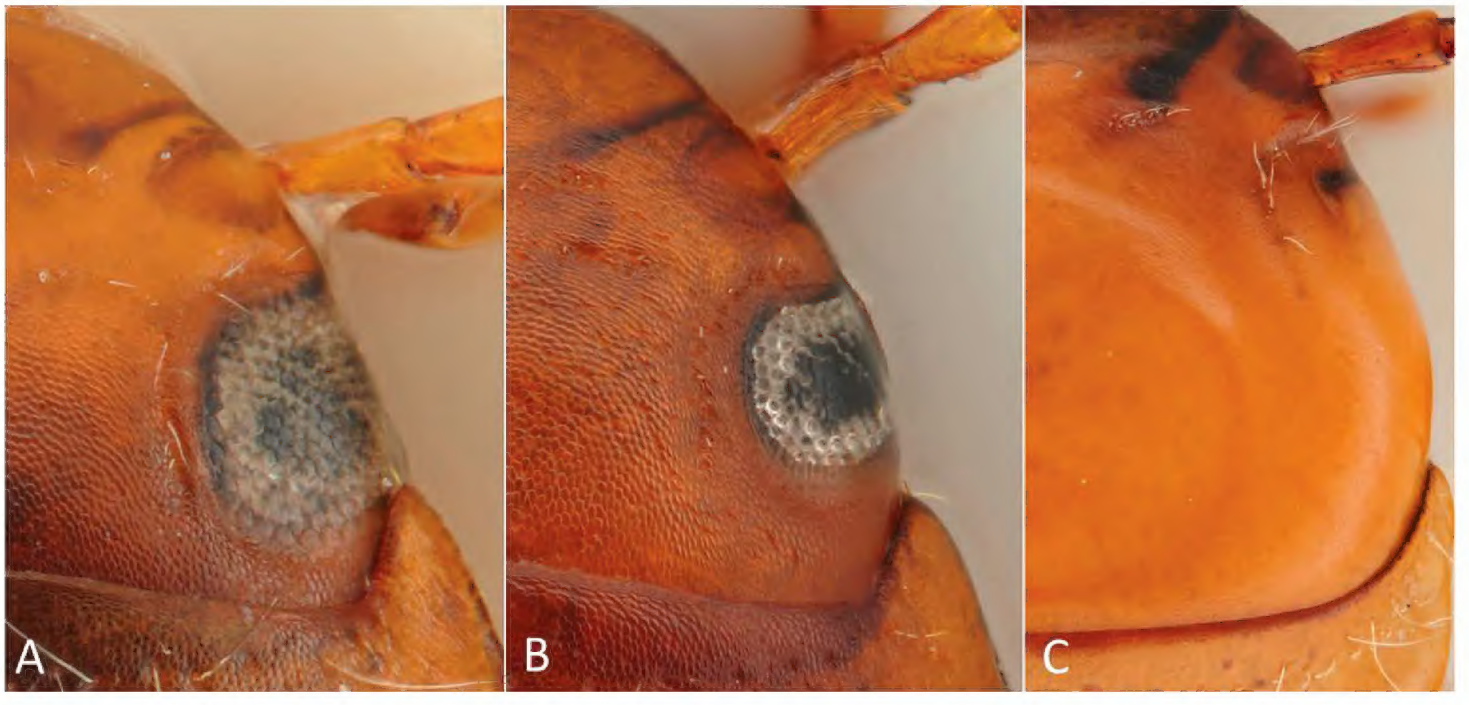

Figure 3. Right lateral aspect of head of *Exocelina* species: *E. ferruginea* (**A**), E. *saltusholmesensis* sp. n. (**B**), *E. abdita* (**C**).

Surface sculpture. Head (frons), pronotum and elytra striolate; with distinct mircoreticulation and coarser punctation. Metacoxal plates and ventrites 1–4 with few strioles, otherwise with fine mircoreticulation and few punctures. The sixth (apical) ventrite broadly rounded.

Structures. Eyes small in comparison to epigean *Exocelina,* length of eye *c.* 0.16 mm, distance between eyes *c.* 0.86 mm (Figs 1C, 3B). Pronotum with faint lateral

bead that does not reach anterior corner. Prosternal process lanceolate, gently rounded ventrally; lateral wings of metaventrite narrow. Flight wings vestigial.

Male. Unknown.

Etymology. The name is an adjective is the nominative singular derived from the locality name – Holmes Jungle. Latin: saltus = woodland.

Differential diagnosis. The species is sister to a clade containing *Exocelina punctipennis* (Lea, 1899) and *E. ferruginea* (Sharp, 1882) established based on DNA sequence data (Toussaint et al. 2015), but both these species are larger (> 5mm), and have larger eyes (Figs 1A–C, 3A, B). Both are epigean species, distributed along the eastcoast of Queensland (*E. punctipennis*) and the Adelaide Hills in South Australia (*E. ferruginea*) (Hendrich et al. in prep.). They are also fully winged.

Habitat. A small pool in the bed of a small ephemeral creek through eucalypt woodland. A small eyed, wingless Hydraenidae (*Hydraena wattsi* Perkins, 2007) was collected at the same time (Perkins 2007). During the dry season (June–September) this creek dries out. However, we assume that subsurface water remains in the watercourse during this season providing an interstitial habitat for these flightless, low vagility species.

Discussion

A number of West Palearctic diving beetle species are known from wells or from the interstitial of gravel banks along rivers. These were classified as semi-subterranean or interstitial species. Morphological characters hinting at this include the reduction of eyes, depigmentation, presence of long sensory setae and the reduction of wings (e.g. Fery et al. 2012; Hernando et al. 2012; Manuel 2013).

While the Australian ground water fauna is well studied and is now known to harbour a considerable diversity of diving beetle species (Watts and Humphreys 2009 and previous; Leys et al. 2003; Balke et al. 2004; Watts and Leijs 2005). Interstitial habitats remain much less explored although already known to contain specialised species (e.g. *Limbodessus rivulus* (Larson, 1994), apterous species of *Carabhydrus* Watts, 1978 (Hendrich and Watts 2009), *Limbodessus occidentalis* (Watts & Humphreys, 2004)). Here we add another candidate from interstitial fauna that might document the first steps into fully underground habitats and highlights the need for focused investigations of such habitats in Australia and beyond.

Acknowledgements

We thank Eduardo ("Edu") Orduña (El Pont de Suert, Spain) and Hans Fery (Berlin) for his help composing the name properly and Remko Leys (Adelaide) for sharing DNA sequence data.

References

Balke M, Watts CHS, Cooper SJ, Humphreys WF, Vogler AP (2004) A highly modified stygobiont diving beetle of the genus *Copelatus* (Coleoptera, Dytiscidae): taxonomy and cladistic analysis based on mitochondrial DNA sequences. Systematic Entomology 29(1): 59–67. doi: 10.1111/j.1365-3113.2004.00229.x

Clark H (1863) Catalogue of the Dytiscidae and Gyrinidae of Australasia, with descriptions of new species. The Journal of Entomology. Descriptive and Geographical 2: 14–23.

Fery H, Pešić V, Darvishzadeh I (2012) Faunistic notes on some Hydradephaga from the Khuzestan, Hormozgan and Sistan & Baluchestan provinces in Iran, with descriptive notes on the female of *Glareadessus franzi* Wewalka & Biström 1998 (Coleoptera, Dytiscidae, Noteridae). Linzer biologische Beiträge 44(2): 1057–1070.

Hendrich L, Watts CHS (2009) Taxonomic revision of the Australian predaceous water beetle genus *Carabhydrus* Watts, 1978 (Coleoptera: Dytiscidae, Hydroporinae). Zootaxa 2048: 1–30.

Hernando C, Aguilera P, Castro A, Ribera I (2012) A new interstitial species of the *Hydroporus ferrugineus* group from north-western Turkey, with a molecular phylogeny of the *H. memnonius* and related groups (Coleoptera: Dytiscidae: Hydroporinae). Zootaxa 3173: 37–53.

Larson DJ (1994) *Boongurrus rivulus*, a New Genus and Species of Water Beetle (Coleoptera: Dytiscidae: Bidessini) from Northern Queensland, Australia. Australian Journal of Entomology 33(3): 217–221. doi: 10.1111/j.1440-6055.1994.tb01222.x

Lea AM (1899) Descriptions of new species of Australian Coleoptera – Part V. Proceedings of the Linnean Society of New South Wales 23: 521–645.

Leys R, Watts CHS, Cooper SJ, Humphreys WF (2003) Evolution of subterranean diving beetles (Coleoptera: Dytiscidae Hydroporini, Bidessini) in the arid zone of Australia. Evolution 57(12): 2819–2834. doi: 10.1111/j.0014-3820.2003.tb01523.x

Leys R, Roudnew B, Watts CHS (2010) *Paroster extraordinarius* sp. nov., a new ground-water diving beetle from the Flinders Ranges, with notes on other diving beetles from gravels in South Australia. Australian Journal of Entomology 49: 66–72. doi: 10.1111/j.1440-6055.2009.00738.x

Manuel M (2013) A new semi-subterranean diving beetle of the *Hydroporus normandi*-complex from south-eastern France, with notes on other taxa of the complex (Coleoptera: Dytiscidae). Zootaxa 3652(4): 453–474. doi: 10.11646/zootaxa.3652.4.4

Nilsson AN (2015) A World Catalogue of the Family Dytiscidae, or the Diving Beetles (Coleoptera, Adephaga). Version 01.01.2015. http://www2.emg.umu.se/projects/biginst/andersn/

Perkins PD (2007) A revision of the Australian species of the water beetle genus *Hydraena* Kugelmann (Coleoptera: Hydraenidae). Zootaxa 1489: 1–139.

Sharp D (1882) On aquatic carnivorous Coleoptera or Dytiscidae. Scientific Transactions of the Royal Dublin Society 2(2): 179–1003.

Toussaint EF, Hall R, Monaghan, MT, Sagata K, Ibalim S, Shaverdo HV, Vogler AP, Pons J, Balke M (2014) The towering orogeny of New Guinea as a trigger for arthropod megadiversity. Nature Communications 5: e4001. doi: 10.1038/ncomms5001

Toussaint EF, Hendrich L, Shaverdo H, Balke M (2015) Mosaic patterns of diversification dynamics following the colonization of Melanesian islands. Scientific Reports 5: e16016. doi: 10.1038/srep16016

Watts CHS, Humphreys WF (2004) Thirteen new Dytiscidae (Coleoptera) of the genera *Boongurrus* Larson, *Tjirtudessus* Watts & Humphreys and Nirripirti Watts and Humphreys,

from underground waters in Australia. Transactions of the Royal Society of South Australia 128: 99–129.

Watts CHS, Humphreys WF (2009) Fourteen new Dytiscidae (Coleoptera) of the genera *Limbodessus* Guignot, *Paroster* Sharp, and *Exocelina* Broun from underground waters in Australia. Transactions of the Royal Society of South Australia 133(1): 62–107.

Watts CHS, Leijs R (2005) Review of the epigean species of Australian *Limbodessus* Guignot (Insecta: Coleoptera: Dytiscidae). Transactions of the Royal Society of South Australia 129(1): 1–13.